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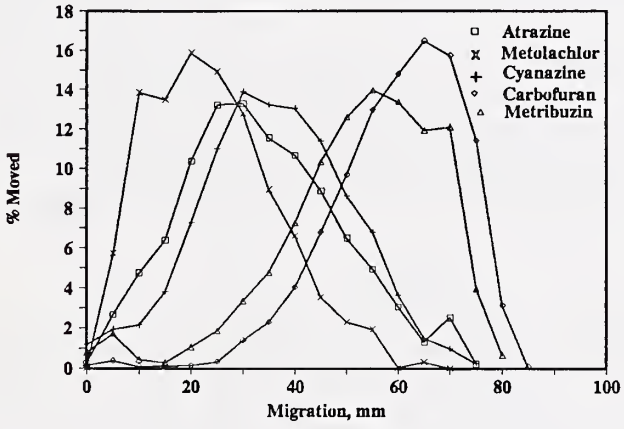
GROUNDWATER RESEARCH

BELTSVILLE AGRICULTURAL RESEARCH CENTER

ANNUAL REPORT 1990



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GROUNDWATER RESEARCH AT THE BELTSVILLE AGRICULTURAL RESEARCH CENTER
ANNUAL REPORT CY 1990

Jerry C. Ritchie (Compiler)

INTRODUCTION

This report covers the activities of scientists at BARC involved in research related to groundwater and groundwater quality. The report has been divided into four (4) section.

SECTION 1.

This section covers the research accomplished in CY1990. A short narrative of the purpose, accomplishment, and application of the different research is given. These narratives have been adapted from the 1990 CRIS Annual Reports.

SECTION 2

List of papers published or accepted for publication in 1990.

SECTION 3

List of published abstracts for papers presented in 1990.

SECTION 4

List of papers with an interpretive summary and a technical abstract that have been reviewed and approved for publication by ARS. These summaries are available in the ARS TEKTRAN (Technology Transfer Automated Retrieval System).

A search for "groundwater" papers in TEKTRAN listed 117 papers by ARS scientists for the period between January 1989 and January 1991 with 18 (15%) authored or co-authored by BARC scientists. However, I found 38 paper on groundwater by BARC scientists that have been approved and are available through the TEKTRAN system for the two year period.

SUMMARY

BARC scientists are actively involved in research to help better understand and manage groundwater quality. Research is underway to 1) develop data bases, 2) develop expert systems, 3) develop and validate models, 4) measure and understand N and pesticide transport, 5) measure and understand volatilization and its impact on chemical loss, 6) develop methods to biodegrade pesticide wastes, 7) develop management systems to minimize N and pesticides loss from agricultural fields, and 8) develop basic and theoretical understanding of chemical transport in agricultural, riparian, and natural ecosystems.

DISCLAIMER

Hopefully this compilation is representative of the research on groundwater at BARC. I have probably missed some that should have been included. If I have, let me know so that we can all know the complete groundwater program at BARC. If you have any general questions call me (Jerry C. Ritchie 344-3490). If you have technical questions call the scientist doing the research and see how you can become involved.

SECTION 1

RESEARCH ACCOMPLISHMENT 1990

1990 ANNUAL REPORT ON GROUNDWATER QUALITY RESEARCH AT BARC

ARS PESTICIDE PROPERTIES DATABASE

Pesticides are increasingly being found in trace amounts in our water supplies. To eliminate or reduce the risk of future water pollution, a database was developed that contains data on 16 properties of 92 pesticides. These properties are important to modelers and managers trying to predict the potential of various pesticides to move to the groundwater under a range of weather and soil conditions. The database has been released to SCS for use in their management programs. Additional pesticides are being added to the database.

CRIS 0500-00026-003-00 D Dr. Acock

NUMEX - AN EXPERT SYSTEM FOR NUTRIENT MANAGEMENT

A combined expert and laboratory information system for nutrient management (NUMEX) was delivered to the Soil Testing Laboratory of the University of Maryland. NUMEX accumulates data on the history of a field, the fertilizer content of soils submitted for analysis and the nutrient content of manures available. Based on this information recommendations are made for the amount of manure, commercial fertilizer, etc. to apply to maximize crop growth while minimizing contamination of water supplies. NUMEX is currently being adapted for Midwest conditions.

CRIS 1270-61000-005-00 D Dr. Lemmon

TRANSPORT PARAMETERS EFFECTING FIELD-SCALE PESTICIDE BEHAVIOR

Theoretical evaluation of field-scale pesticide transport parameters were examined for no-till and conventional till systems in continuous corn production. Atrazine, alachlor, and cyanazine were applied in a single surface broadcast spray and carbofuran was incorporated into the soil matrix. Surface broadcast pesticides were more susceptible to preferential (macropore) transport than soil incorporated carbofuran. At 1.2 m depth, less than 1% of the total soil volume was used to transport 9% of the surface broadcast pesticide.

CRIS 1270-11130-005-00 D Dr. Gish

STARCH-ENCAPSULATED PESTICIDES TO MINIMIZE TRANSPORT

Laboratory studies have been conducted to evaluate starch-encapsulated pesticides for controlling pesticide transport under environmental conditions favorable to preferential (macropore) transport. In replicated soil columns from established no-till sites, less than 1% of the jet-cooked, starch-encapsulated atrazine had leached from columns after 21 days, compared to 35% for the technical grade atrazine treatment. These studies show the potential for starch-encapsulated pesticides for reducing pesticide transport to the groundwater.

CRIS 1270-11130-005-00 D Dr. Gish

METHOD TO MEASURE STARCH-ENCAPSULATED PESTICIDE RESIDUES

An enzymatic heat pretreatment extraction process was developed allowing quantitative measurements of atrazine mass to be determine in jet-cooked starch-encapsulated formulations. This method is critical for conducting quantitative laboratory and field-scale environmental fate studies on starch-encapsulated pesticides.

CRIS 1270-11130-005-00 D Dr. Gish

DEVELOPMENT OF A GROUNDWATER STUDY SITE

A field project on pesticide movement to the groundwater is now in its fifth year. Analysis of pesticide residues in soil for previous years showed that sampling depths and frequencies can be reduced. Additional equipment was added for monitoring information (daily evaporation rates, soil hydraulic conductivity, and water table elevations) needed for model evaluation. Flumes fitted with flow meters and automatic samplers were installed on each plot. Data collected from these plots will allow the development of budgets for chemical movement studies.

CRIS 1270-13000-003-00 D Dr. Isensee/Sadeghi

PESTICIDE MOVEMENT UNDER DIFFERENT MANAGEMENT PRACTICES

No-till (NT) and conventional-till (CT) corn plots were treated with atrazine, alachlor, cyanazine, and paraquat. Water from shallow (1-3m) and deep (4-13 m) wells, runoff from rain and irrigation events, soil and crop residue were sampled and analyzed. A rain event 3 days after pesticide application resulted in more leaching to groundwater under NT than under CT. Runoff was three to five times greater from CT than NT plots while pesticide residue concentrations in the runoff was comparable. Herbicide residue concentrations in the top 10 cm of the soil under CT plots were 2X higher than under NT plots 13-15 days after application in 1986-1988. These differences were consistent even though rainfall patterns (time after application and amount) varied significantly between years. Crop residue on the soil surface of the NT plots was apparently responsible for the observed herbicide residue difference between tillage systems.

CRIS 1270-13000-003-00 D Dr. Isensee/Sadeghi

DEGRADATION OF ORGANIC PESTICIDES WASTES

Ozonzation pretreatment enhances the biodegradation of pesticides. This process has been applied to pesticide wastes and rinsates containing ammonia from fertilizers, formulating agents or detergent rinses in an effort to prevent groundwater pollution. Significant reduction of pesticide wastes have been found.

CRIS 1270-12130-001-00 D Dr. Somich/Shelton

VOLATILIZATION OF PESTICIDES

The effects of conservation tillage on pesticide volatilization was investigated by measuring volatilization of atrazine, chlorpyrifos, and fonofos from side-by-side no-till and conventionally tilled fields. Volatilization losses from no-till fields were usually much greater than from conventional till, especially for fonofos. These studies show the potential for loss of pesticides from agricultural systems by volatilization.

CRIS 1270-11130-004-00 D Dr. Whang

METHODS TO STUDY PESTICIDE RECOVERY FROM WELL WATER

Organic contaminates from well water were recovered by solid phase extraction (SPE). When SPE was used as an extraction method for analysis of pesticide in water good recoveries were obtained. In humic acid solutions recovery was reduced. Recoveries from ground and surface waters were found to be pesticide dependent. Pesticide partition coefficients between true solution and the dissolved organic matter phase were determined. These techniques will allow better evaluation of pesticides in groundwater.

CRIS 1270-12130-004-00 D Dr. Herner

CHANGES IN GROUNDWATER QUALITY DURING PASSAGE THROUGH RIPARIAN ZONES

Several field methods are being developed and tested to characterize and quantify processes effecting the fate of nitrate and pesticides in shallow saturated regions of riparian zones. The methods range from qualitative survey procedures to intensively control quantitative procedures. Bromide-nitrate ratios are being used to assess relative denitrifying activities. Information from these studies will provide SCS and scientists with guidelines for developing farm management practices to minimize transport of nutrients to streams.

CRIS 1270-12140-002-00 D Dr. Starr

WINTER COVER CROPS REDUCE N LOSS

Winter cover crops can reduce nitrate leaching by utilizing both N and water. Both legumes and grasses are utilized as cover crops, but their ability to recycle fertilizer N in the field has not been evaluated. The ability of grass vs. legume cover crops to retain corn fertilizer N was evaluated by adding 15N labelled fertilizer to corn, subsequently growing grass and legume covers and measuring labelled N uptake by the covers. Grasses (cereal rye and ryegrass) retained 50-60% of the fertilizer N, while legumes (hairy vetch and crimson clover) retained 10% or less. Grass cover crops are clearly superior to legumes in conserving residual fertilizer N which should reduce nitrate transport to ground water.

CRIS 1270-12130-003-00D Dr. Meisinger

METHOD TO IDENTIFY N RICH SITES

A "N screening model" was develop to identify N rich sites by estimating field scale N budgets. The budgets are developed by inventorying the managed N components (fertilizers or manure inputs and crop removals) and by estimating the non-managed components (denitrification, ammonia loss, etc.) through soil properties and climatic data. The model qualitatively identifies N rich sites in order to 1) define areas for further sampling to quantify the extent of the nitrate problem, and 2) define areas where extension education programs could be implemented to reduce the risk of nitrate enrichment of groundwater.

CRIS 1270-12240-001-00 D Dr. Meisinger

SECTION 2

PUBLICATIONS 1990

PUBLICATION - BARC GROUNDWATER RESEARCH - 1990

Adams, D.D., N.J. Fendinger, and D.E. Glotfelty. 1990. Biogenic gas production and mobilization of in-place sediments contaminants by gas ebullition, pp 215-236, Lewis Publ. Inc., Chelsea, MI.

Fendinger, N.J. and D.E. Glotfelty. 1990. Henry's Law constants for selected pesticides, PAHS, and PCBS. Environ. Toxic. Chem. 9:731-735.

Gish, T. J., C. S. Helling, and M. Mojasevic. Preferential movement of atrazine and cyanazine under field conditions. Trans. Amer. Soc. Agric. Engin. (accepted 11/90 for publication).

Gish, T. J., A. R. Insensee, R. G. Nash, and C. S. Helling. Impact of preferential transport of pesticides on water quality. Trans. Amer. Soc. Agric. Engin. (accepted 10/90 for publication).

Gish., T. J., M. J. Schoppet, C. S. Helling, A. Shirmohammadi, M. M. Schreiber, and R. E. Wing. Transport comparison of starch-encapsulated atrazine. Trans. Amer. Soc. Agric. Engin. (accepted 11/90 for publication)

Haverkamp, R., J.Y. Parlange, J.L. Starr, G. Schmitz, and C. Fuentes. 1990. Infiltration under ponded conditions: 3-A predictive equation based on physical parameters. Soil Sci. 149:300-308.

Holderbaum, J.F., A.M. Decker, J.J. Meisinger, F.R. Mulford, and L.R. Vough. 1990. Harvest management of a crimson clover cover crop for no-tillage corn production. Agron. J. 82:918-923.

Isensee, A.R. 1991. Dissipation of alachlor under in situ and simulated valdose zone conditions. Bull. Environ. Contam. Toxicol. 46:

Isensee, A.R., R.G. Nash, and C.S. Helling. 1990. Effect of conventional vs. no-tillage on pesticide leaching to shallow goundwater. J. Environ. Qual. 19:434-440.

Kunishi, H.M. and A.M. Sadeghi. 1991. Simulation of one-dimensional nitrate transport through soil and concomitant nitrate diminution. Soil Sci. 67:

Lusby, W.R., C.S. Helling, and C.J. Somich. 1990 Detection of tebuthuron herbicide from soil by selected ion electron capture negative-ion mass spectroscopy. Proc. 38th Annual Conf. Am. Soc. Mass Spectrometry, pp. 683-684.

Majewski, M.S., D.E. Glotfelty, K.T. Paw U, and J.N. Seiber. 1990. A field comparison of several methods for measuring pesticide evaporation rates from soil. Environ. Sci. Technol. 24:1490-1497.

Meisinger, J.J. and G.W. Randall. 1990. Estimating N budgets for soil-crop systems. IN: R.F. Follett (ed.), Managing N for Groundwater Quality and Farm Profit, Am. Soc. Agron., Madison, WI.

Meisinger, J.J. and G.W. Randall. 1990. Literature Summary: Estimating change in N storage. IN: R.F. Follett (ed.), Managing N for Groundwater Quality and Farm Profit, Am. Soc. Agron., Madison, WI.

Meisinger, J.J., P.R. Shipley, and A.M. Decker. 1990. Using winter cover crops to recycle nitrogen and reduce leaching. N.C. State Univ. Spec. Bull. 90-1:3-7.

Nash, R.G. 1990. Solid-phase extraction of carbofuran, atrazine, simazine, alachlor, and cyanazine from shallow well water. J. Assoc. Offic. Anal. Chem. 73:438-442.

Palmer, R.E. 1990. Design and evaluation of a lysimeter using large undisturbed coil columns. MS Thesis. Univ. Maryland, 155 pp.

Somich, C.J., M.T. Muldoon and P.C. Kearney. 1990. On-site treatment of pesticide waste and rinsate using ozone and biologically active soils. Environ. Sci. Technol. 24:745-749.

Starr, J.L. 1990. Spatial and temporal variation of ponded infiltration. Soil Sci. Soc. Am. J. 54:629-636.

Starr, J.L. and D.E. Glotfelty. 1990. Atrazine and bromide movement through a silty loam soil. J. Environ. Qual. 19:552-558.

Wienhold, B. J. and T. J. Gish. Enzymatic pretreatment for extraction of starch-encapsulated pesticides from soil. Weed Sci. (accepted 1/91)

SECTION 3

ABSTRACTS 1990

ABSTRACTS

Clark, A.J., A.M. Decker, J.J. Meisinger, and J.F. Holderbaum. 1990. Spring management of hairy vetch/cereal rye mixtures for N production and corn grain yield. Agron. Abstracts, p. 139.

Decker, A.M., J.J. Meisinger, J.F. Holderbaum, and A.J. Clark. 1990. Utilizing winter annual cover crops in no-tillage corn systems. Agron. Abstracts, p. 140.

Gish, T. J., C. S. Helling, B. J. Wienhold. 1990. Time dependent adsorption of five herbicides in a field soil. Agronomy Abstracts, p. 211.

Helling, C. S., M. Mojasevic, and T. J. Gish. 1990. Relative mobility and persistence of pesticides under varying water input regimes. 7th International Conference of Pesticide Chemistry, IUPAC, Hamburg Germany (Abstract No. 07D-13).

Hapeman-Somich, C.J. 1990. Mineralization of pesticide degradation products. Am. Chem. Soc. Meetings Abstracts, AGRO p. 68.

Isensee, A.R. 1990. Laboratory system for studying pesticide leaching under field conditions. Weed Sci. Soc. Am. Abstracts, p 217.

Isensee, A.R. and R.G. Nash. 1990. Variability among monitoring wells for sampling in confined and unconfined groundwater. Am. Chem. Soc. Meetings Abstracts, AGRO p. 29.

Meisinger, J.J., P.R. Shipley, and A.M. Decker. 1990. Winter cover crops to retain N within soil-crop system and reduce nitrate leaching. Agron. Abstracts, p. 152.

Mojasevic, M., C. S. Helling, and T. J. Gish. 1990. A multiresidue method for determination of seven pesticides in soil. 7th International Conference of Pesticide Chemistry, IUPAC, Hamburg Germany (Abstract No. 08B-17).

Sadeghi, A.M., A.R. Isensee, and A. Shirmohammadi. 1990. Tillage practice and pesticide movement: experimental and modeling assessment. Agron. Abstracts, p. 218.

Starr, J.L., J.J. Meisinger, and T.B. Parkin. 1990. Problems and opportunities in valdose sampling. Am. Chem. Soc. Meetings Abstract, p. 47.

Starr, J.L. and A.M. Sadeghi. 1990. Evaluation of an in situ lateral flow chamber for riparian zone research. Agron. Abstracts, p. 219.

Taib, M.A., B.R. James, J.J. Meisinger, and F.R. Mulford. 1990. The impact of tillage and poultry manure on residual soil nitrogen. Agron. Abstracts p. 282.

Wienhold, B. J. and T. J. Gish. 1990. Effect of water potential on rate of release from starch-encapsulated atrazine. Agronomy Abstracts, p. 51.

SECTION 4

ARS APPROVED PUBLICATIONS

1989 - 1990

Technology Transfer Automated Retrieval System - (TEKTRAN)

NO-TILL CORN PRODUCTION: ACHIEVING MAXIMUM NUTRIENT EFFICIENCY

BANDEL V ALLAN
KUNISHI HARRY M
MEISINGER JACK J
MULFORD RONALD F

Interpretive Summary:
Efficient fertilizer N and P management of corn grown under no-till and conventional-till is essential for farm managers seeking to maximize earnings and to minimize potential for nutrient leakage into groundwater systems. Fundamental to efficient management is to test soils for pH and nutrients on a yearly basis. Soil samples from no-till plots should be collected from the 0-2 inch depth at about the same time each year. Soil samples from conventional till plots should be collected from the 0-8 inch depth. The pH of the soil should be corrected with lime application so as to fall between 6-7. For N management, granular applications of N fertilizer applied along corn rows about 3 to 4 weeks after planting maximized fertilizer use and minimized N loss to groundwater; injected forms of N, as ammonia, can be applied earlier without N loss to groundwater, except for sandy soils. For P management under conventional tillage, granular forms of P fertilizer applied in bands along corn rows maximized P uptake; under no-till, surface broadcast applications were observed to be an efficient means of delivering P to plant roots.

Technical Abstract:
This report provides guidelines for N and P management of field corn production under no-till and conventional-till. The results of over 10 years of continuous tillage x fertilizer trials have provided information that can be summarized as follows: for both N and P management, start with a test for soil pH. Use the measured pH as a guide to correct pH to 6-7. For N management, apply fertilizer as a side-dressing 3 to 4 weeks after planting to minimize leaching losses and to increase recovery of applied N; if being injected as ammonia, application can be made earlier; delayed release forms of N fertilizers did not show any significant increase in plant recovery of added fertilizer. For P management, 1) under conventional tillage, granular P fertilizer applied in bands along corn rows showed highest P fertilizer recovery rates; and 2) under no-till surface broadcast of P fertilizer provided an effective, low cost means of delivering P to corn plants.

Submitted to: (approved 10/02/89)
UNIV OF MD SYSTEM COOPERATIVE EXT SERV
HARRY M KUNISHI 301 344-3511 FTS 344-3511
USDA ARS NRI ECL
BLDG 008 ROOM 101 FAX Number:
BELTSVILLE MARYLAND 20705

A COMPARISON OF TWO EXPERIMENTAL TECHNIQUES FOR DETERMINING AIR-WATER HENRY'S LAW CONSTANTS.

FENDINGER NICHOLAS J
GLOTFELTY DWIGHT E
FREEMAN H. P

Interpretive Summary:
Environmental scientists and engineers' use air/water partition coefficients or Henry's law constants (HLCs) to predict the behavior or organic compounds in the environment. The problem faced by many scientists is the lack of accurate experimentally determined HLCs for compounds that are commonly measured in environmental samples. In this paper, we compare two experimental techniques, the wetted-wall column (WWC) and fog chamber for determining HLCs. Although the WWC was easily set up and dismantled, the fog chamber proved to be a more sensitive technique because of the larger volumes of air and water used for the determination. Because of the excellent agreement of HLCs determined by the two techniques, the data presented can be used by scientists in environmental models with a high degree of confidence.

Technical Abstract:
Henry's law constants (HLCs) were determined with a wetted-wall column (WWC) and a fog chamber. HLC measurements made with the WWC were obtained by equilibrating a pesticide solute between a thin film of water that flows down the inside of a vertical column and a concurrent flow of air. Air-water equilibrium as a pesticide solute was obtained with the fog chamber by aspirating water amended with pesticide into one end of a 17.5 cm id X 62 cm glass chamber and collecting droplets in a cyclone collector at the other end of the chamber. Pesticide concentrations in the collected air and water from both types or apparatus were extracted and analyzed by gas chromatography. Differences between HLCs determined by the two techniques for six pesticides were generally less than 30%.

Submitted to: (approved 06/07/89)
ENVIRONMENTAL SCIENCE AND TECHNOLOGY

NICHOLAS J FENDINGER 301-344-3872 FTS 344-3872
USDA, ARS
ENVIRONMENTAL CHEM. LAB. FAX Number:
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Technology Transfer Automated Retrieval System - (TEKTRAN)

TRANSPORT COMPARISON OF STARCH-ENCAPSULATED ATRAZINE

GISH TIMOTHY J

Interpretive Summary:

Atrazine one of the oldest and most frequently studied herbicides, is also one of the most common pesticide contaminates in ground water. Typically observed concentration levels are below EPA's health advisory level. However, recent field studies have demonstrated that the EPA levels could be substantially exceeded if used in an environment conducive to preferential flow. As a result, a laboratory study was conducted to test the feasibility of utilizing starch-encapsulated atrazine, to minimize leaching under environment conditions favoring preferential transport. Technical grade atrazine and three starch-encapsulated formulations were applied to 40 small soil cores, removed from an established no-till field site. Seven rain simulations were applied to these columns over a 21 day period, the leachate collected after each irrigation event. The greatest atrazine leaching took place during the first irrigation on the technical grade treatment, atrazine levels exceeding all encapsulation treatments by over a factor of 10. Over the duration of the experiment, encapsulating atrazine in a starch matrix, reduced leaching losses from 35% to < 1%. In the first irrigation, the atrazine in the leachate utilized < 10% of the soil volume supporting the hypothesis of preferential movement.

Technical Abstract:

The feasibility of using starch-encapsulated atrazine to minimize convective transport under conditions favoring preferential flow was evaluated. Forty small undisturbed cores were removed from an established no-till field site and randomly grouped into one of five treatment formulations: i) technical grade atrazine; ii) borate process, starch-encapsulated; iii) jet-cooked pearl starch-encapsulated; iv) jet-cooked, waxy starch-encapsulated; and v) untreated controls. Columns were irrigated with 0.01 N CaCl2 applied through a drip system, at the rate of 2.5 cm every three days Column effluent was collected and analyzed for atrazine as a function of time. Highest atrazine residue levels, 1.30 mg L-1, were observed in the effluent of the nonformulated herbicide after the first irrigation. Piston and convection-dispersion transport simulations predicted transit times that where almost an order of magnitude later than indicated from observed atrazine concentrations in the technical grade treatment. Starch-encapsul ation reduced atrazine formulations revealed little temporal variability in the effluent concentrations, while the technical grade demonstrated temporal coefficients of variation of 99%.

Submitted to: (approved 07/20/90)
TRANS OF THE AMER SOC OF AGR ENGRS

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Technology Transfer Automated Retrieval System - (TEKTRAN)

IMPACT OF PREFERENTIAL TRANSPORT OF PESTICIDES ON WATER QUALITY

GISH TIMOTHY J

Interpretive Summary:
A three-year cornfield study in Maryland showed that in dry years, pesticides levels in a shallow perched ground water were negligble, regardless of tillage practice. However, in 1988 a long-duration, low-intensity rain event occurred 12 hours after pesticide application, resulting in significant concentrations of all pesticides in the perched water table. Additionally, pesticide levels were highest under no-till management; atrazine was four times higher under no-till than conventional tillage; cyanazine and alachlor almost three times higher; and carbofuran almost 13 times higher. The enhanced movement of the pesticides in 1988 was a result of preferential transport, a process whereby the chemicals move rapidly through void root channels, and soil cracks, bypassing much of the soil volume which has a high affinity for these compounds.

Technical Abstract:
A three-year field study was conducted to determine the impact of tillage practice, mode of pesticide application, and pesticide formulation of chemical transport. Pesticides evaluated were atrazine, cyanazine, carbofuran, and alachlor. Atrazine and cyanazine were applied as solutions whereas alachlor was applied as an emulsifiable concentrate in 1986, and as a microencapsulated formulation in 1987 and 1988. Carbofuran was band-injected at planting the day prior to the other three compounds. Drought conditions were experienced in 1986 and 1987; at which time only atrazine appeared in any significant concentrations, mean field-scale values ranging from 0.4 to 2 ug L -1. In May 1988, 12 hours after application, an extended, low-intensity, rain event occurred which administered 4.8 cm of water to the field site. Six days after the 1988 application, significant concentration of all pesticides were detected at approximately 1 m. Atrazine and cyanazine showed significant preferential transport, where concentration levels were almost an order of magnitude higher than those under conventional tillage. At least 9% of the available atrazine and cyanazine had leached to the shallow water table, utilizing <1% of the total soil vol. Incorporating carbofuran, and utilizing microencapsulated alachlor appears to have minimized the effect of pref. transport .

Submitted to: (approved 08/06/90)
TRANSACTION OF AMER SOC OF AG ENGNRS

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PREFERENTIAL MOVEMENT OF ATRAZINE AND CYANAZINE AS AFFECTED BY TILLAGE AND WATER INPUT

GISH T J
HELLING C S & MOJASEVIC M

Interpretive Summary:
Presently, field-scale pesticide interactions as well as the physics a associated with fluid dynamics through soils is poorly understood. As a result, best management practices and tillage effects cannot be accurately simulated. Perhaps the most critical and least understood transport mechanism responsible for the observed simulation discrepancies is preferential flow. This mechanism exhibits a high degree of spatial and temporal variability, making it necessary to collect a large number of observations thus increasing the probability of capturing the effects of a preferential flow event. In this light, two field studies were conducted. The first, in 1984, evaluated the movement of atrazine and cyanazine on an established no-till site, were all water inputs were through rain events. Atrazine and cyanazine, two commonly used herbicides were evaluated as they have similar mobilities but differ dramatically in persistence. The second phase was conducted on a tilled plot, 30 x 15 m in 1986, exposed to frequent high intensity water inputs. Although preferential transport was observed under both sites, the no-till site had the most rapid movement relative to water inputs. Persistence of both herbicides agree well with published literature values and was unaffected by tillage.

Technical Abstract:
The relative importance of preferential pesticide transport in agricultural soils was determined in a two-phase study conducted on a silt loam soil in Maryland. The first phase (1984) consisted of evaluating persistence and mobility of atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] and cyanazine [2-chloro-4-(cyano-1-methylethylamino)-6-ethylamino-s-triazine] under no-tillage corn management. The second phase (1986) dealt with persistence and mobility of the same herbicides on tilled soil subjected to frequent, large water inputs. Although preferential flow was observed under both treatments and water regimes, the no-till system had the most rapid movement relative to water inputs. Additionally, all treatments indicated that the greatest potential movement of surface-applied pesticide occurred with the first water input subsequent to application. Once the pesticide has been preferentially transported, it appears to diffuse into the soil matrix, where it is no longer subject to significant preferential movement. Persistence of atrazine and cyanazine was unaffected by tillage practiced and water regime.

Submitted to: (approved 09/21/89)
TRANSACTIONS OF ASAE

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Technology Transfer Automated Retrieval System - (TEKTRAN)

ION CHROMATOGRAPHY: A TOOL IN SHALLOW GROUNDWATER INVESTIGATIONS

GISH T J
SCHOPPET M J

Interpretive Summary:
As fertilizer and pesticide use have increased to maintain agricultural productivity, so have concerns regarding their eventual environmental fate. Unfortunately, our ability to describe or simulate chemical movement on a field-scale is limited due to complex chemical interactions as well as temporal and spatial varying transport parameters. In order to understand and simulate field-scale transport processes, a probabilistic approach is needed. Such an approach requires a large number of observations which is time consuming and expensive. As a consequence, new technologies must be employed which will reduce analytical time and costs. To this end, a totally automated ion chromatography system was designed and tested. Not only were analytical costs reduced, but chemical sensitivity increased by over an order of magnitude. The ion chromatography system allows for sampling procedure, processing and analysis to be programmed through a personal computer. All data is stored on a hard disk, and can be easily accessed for additional analysis or manipulation. Two methods were analyzed, and discussed with regard to sensitivity and rapid detection in an unsupervised, automated mode.

Technical Abstract:
At present, there is a general concern over the use of agricultural chemicals which pose a threat to groundwater. As solute tracers are being used to estimate the movement of some agricultural compounds, ion chromatography may play an important role in groundwater research as it offers increased sensitivity and lends itself to being fully automated. Although several ion chromatography methods were evaluated, only two will be report here. The first uses a 2.6 mM benzoic acid mobile phase, titrated to pH 6.72 with lithium hydroxide. The second method uses 1.0 mM potassium hydrogen phthalate solution, titrated to pH 6.5 with lithium hydroxide. Both mobile phases gave good peak separation, reproducibility, and allowed accurate detection of anion concentrations below 100 ppb. The benzoic acid mobile phase was not suited for automation as the analytical column started to loose sensitivity rapidly after 75-100 injections of 100 ul each. Reduction in column sensitivity was associated with soluble organics and sulfate adsorption. Using the 1.0 mM potassium hydrogen phthalate eluent, anion concentrations could be detected below 100 ppb after 1000 injections. All anions evaluated yielded linear peak area-anion concentration relationships; however, a quadratic formulation gave increased accuracy when evaluating over a wide range in concentrations, 0.1-100 mg/L .

Submitted to: (approved 10/02/89)
ADVANCES IN CHROMATOGRAPHY

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RELEASE AND PERSISTENCE COMPARISON OF STARCH-ENCAPSULATED ATRAZINE

GISH T J
SCHOPPET M J
WIENHOLD B J
HELLING C S
SCHREIBER M M

Interpretive Summary:
With the increased interest in water quality issues, polymer chemists and soil scientists are combining their expertise to develop controlled release pesticide formulations. By encapsulating pesticide in a starch matrix, its release into the environment can be controlled. However, the release of pesticide from the starch matrix will be governed by a number of variables, such as: type of encapsulation process, type of starch, and soil physical properties. This investigation focuses on the affect of the water energy status on the release and persistence of several starch-encapsulated atrazine formulations. Results indicate that as the energy status of the water decreases so does the atrazine release rate. In addition, the persistence of the starch-encapsulated atrazine relative to non-encapsulated treatment appears to be a short term phenomena, due to the biological decomposition of the starch matrix.

Technical Abstract:
The release of atrazine as a function of water potential, and laboratory persistence rates were evaluated for three starch-encapsulated formulations. Capsule swelling and atrazine release rates from borate, jet-cooked pearl starch, and jet-cooked waxy starch were evaluated at several water potentials from 0 to -1.5 MPa. Generally, both the rate of atrazine release as well as the maximum equilibrium solution concentration decreased with decreasing water potential. Although starch-encapsulated atrazine is more persistent than non-encapsulated, it appears to be a short term phenomenon, related to the biodegradability of the starch matrix.

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WEED SCIENCE

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DISTRIBUTION OF SEVERAL ORGANOPHOSPHORUS INSECTICIDES AND THEIR OXYGEN ANALOGUES IN A FOGGY ATMOSPHERE

GLOTFELTY DWIGHT E
MAJEWSKI M. S
SEIBER J. N

Interpretive Summary:
Pesticides enter the atmosphere by drift during spraying, and by post-application volatilization and wind erosion. Once in the atmosphere, they may be carried by the wind and return to the surface as widespread, low-level contamination. How far they are transported, and where they will return is determined in part by their association with atmospheric moisture. The present study of the distribution of pesticides in a foggy atmosphere shows that it is not always possible to predict the distribution of pesticides between air and water in the atmosphere. Sometimes they are more soluble in the water phase than expected. Even in a foggy atmosphere, however, most of the pesticides studied remained in the air phase between the fog droplets. We also learned that pesticides in fog may be a source of contamination of vegetation through the deposition pesticide-containing fog droplets.

Technical Abstract:
We measured the distribution of four organosphosphorus insecticides and their oxon transformation products between the droplet and air phases during 6 fog events. We found up to 39 ppb of the parent insecticides and up to 34 ppb of the oxons in the fogwater. In agreement with earlier studies, nearly all the compounds exhibited aqueous-phase concentrations much higher than would be expected from measured vapor concentrations and Henry's Law. Even though high concentrations and high enrichments were found in the aqueous phase, for most of the compounds the largest proportion was present in the interstitial air phase, either as vapor or adsorbed to aerosol particles. Only very small amounts (<1%) of any of the compounds were found associated with particles within the fog droplets.

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ENVIRONMENTAL SCIENCE AND TECHNOLOGY

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PRELIMINARY STUDIES OF THE DISTRIBUTION, DRIFT, AND VOLATILIZATION OF DIAZINON RESULTING FROM SPRAY APPLICATION TO A DORMANT PEACH ORCHARD

GLOTFELTY DWIGHT E
SCHOMBURG CHARLOTTE J
MCCHESNEY MICHAEL M
SAGEBIEL JOHN C
SEIBER JAMES N

Interpretive Summary:
Occasionally illegal pesticide residues are found on crops to which the pesticide was never applied. How did the pesticide get onto the crop? The pesticide may have drifted from a neighboring field during spray application. Alternatively, the pesticide may have volatilized from the application site and been carried and deposited by rain, fog droplets or dust particles. As a first step in distinguishing between spray drift and other forms of pesticide loss from an application site an experiment was conducted to determine how much of a pesticide was lost from a dormant peach orchard during spray application and how much volatilized in the next few days after application. To accomplish this air samples were collected during spray application and for the next few days after application. Soil and tree rinse samples were also collected to determine how the spray was distributed in the orchard. Results showed while there is pesticide loss from the orchard during spray application, there is also continuing loss by volatilization after application. Also it seems more of the pesticide is found on the soil than on the trees in the orchard. From this preliminary work we have found may ways to improve these kinds of field measurements. This information will serve to help us in future experiments of this type and also other scientist doing these kinds of experiments.

Technical Abstract:
A preliminary experiment was conducted to determine the spray distribution, spray drift, and volatilization of diazinon applied in the conventional manner with an air-blast sprayer to a dormant peach orchard. Copper hydroxide and a dormant oil were applied along with the diazinon. Soil samples and tree rinse samples were used to determine the distribution in the orchard. Airborne losses were calculated by the integrated horizontal flux method from measurements of wind speed and pesticide concentration profiles obtained during and for several days following application. Diazinon was not distributed evenly between the trees and the soil in the orchard according to their relative areas. Most of the diazinon accounted for was found to be on the soil. The residue on the soil dissipated with a 19 day half life. Application drift losses were small compared to long-term volatilization losses, and we conclude that most of the diazinon in the Central Valley atmosphere during the dormant spray season results from volatilization. This result has important implications for designing strategies for controlling inadvertent contamination of other crops and the environment.

Submitted to: (approved 08/07/90)
CHEMOSPHERE

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REGIONAL ATMOSPHERIC TRANSPORT AND DEPOSITION OF PESTICIDES IN MARYLAND

GLOTFELTY D. E
WILLIAMS G. H
FREEMAN H. P
LEECH M. M

Interpretive Summary:
Some pesticides inadvertently enter the atmosphere because of application drift, post-application volatilization, and wind erosion of pesticide-bearing dust. Rain carries part of this airborne pesticide back to the surface as widespread, low-level environmental contamination. We conducted a study to measure the deposition of selected pesticides to Chesapeake Bay with rain, and to compare the atmospheric input to transport to the Bay by rivers and streams. We verified that some pesticides are indeed carried to the Bay by the atmosphere. Most of the deposition occurs during the time pesticides are being used locally, but we also found evidence that a part of several of the pesticides reaching the Bay came from sources as much as one thousand km away. The amount carried to the Bay was different for each chemical. Only a small percentage of atrazine and simazine was carried to the Bay in rain; the majority of these two chemicals entered the Bay through fresh water tributaries. On the other hand, as much as 20 to 50% of alachlor, metholachlor, and toxaphene in the Bay were derived from rain. Our study is the first in which quantitative estimates of the atmospheric input of toxics to Chesapeake Bay are reported.

Technical Abstract:
We measured concentrations in air and total deposition (primarily rainout) of atrazine, simazine, alachlor, metolachlor, and toxaphene at several locations in Maryland. Concentrations in air and rain peaked during local application seasons, but atrazine, simazine, and toxaphene gave evidence of at least regional-scale transport. Alachlor and metolachlor, on the other hand, appear to be too rapidly degraded in the atmosphere for long-range transport. Rain deposited 2-3% of the atrazine and simazine, about 20% of the alachlor, and possibly larger percentages of toxaphene in Wye River; the remainder was delivered by surface runoff. We estimate that rain deposited 0.6-1.2 metric tons (MT) of atrazine, 0.11-0.14 MT of simazine, 2.4-9.8 MT of alachlor, and 0.54-1.1 MT of toxaphene on Chesapeake Bay during the summers of 1981, 1982, and 1984.

Submitted to: (approved 08/11/89)
PROC. SYMP. LONG-RANGE TRANSPORT OF

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INFILTRATION UNDER PONDED CONDITIONS. 3: A PREDICTIVE EQUATION BASED ON PHYSICAL PARAMETERS.

HAVERKAMP R
PARLANGE J Y
STARR JAMES L

Interpretive Summary:
The previous infiltration equation, described in Part I of this series is improved in such a way that it applies equally well for infiltration and capillary rises. The new infiltration equation permits prediction of water infiltration from well-defined physical soil parameters.

Technical Abstract:
A new infiltration equation is derived, which takes into account the possibility of an infinite diffusivity near saturation. It is shown with the example of two soils (clay and coarse sand), that this new infiltration equation has a sound physical basis. In particular all parameters used are true soil properties which are constant with time and independent of the water depth imposed as surface boundary condition. Compared with analytical, numerical and experimental results, the equation shows a great precision at all times. The present law introduces a significant improvement over the law obtained in Part I of this series dealing with ponded infiltration, by introducing the physical effect of an infinite diffusivity at saturation.

Submitted to: (approved 03/15/90)
SOIL SCIENCE

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Technology Transfer Automated Retrieval System - (TEKTRAN)

MOVEMENT OF HERBICIDES IN TERRESTRIAL AND AQUATIC ENVIRONMENTS

ISENSEE ALLAN R

Interpretive Summary:
Herbicides, which are primarily applied to the terrestrial environment, may move (through volatilization, runoff, or leaching) away from the target area both during and after application. Movement of herbicides away from their point of application represents both an economic loss (reduced efficacy) and a potential for contamination of nontarget terrestrial and aquatic environments. This book chapter describes how herbicides move in the terrestrial and aquatic environment, what the major transport processes are, their relative importance, and how climatic, edaphic, chemical, and physical factors interact to control the magnitude of transport.

Technical Abstract:
A portion of most herbicides applied to the terrestrial environment are lost to air (volatilization or water runoff or leaching) and may then enter the aquatic environment through aerial deposition, surface runoff or groundwater flow. For most herbicides, the relative importance of the terrestrial loss processes (in terms of potential amount lost) is volatilization > runoff > leaching. The amount of herbicide that moves away from its intended target by air or water is controlled by a number of climatic, edaphic, chemical, and physical factors. The interactions of the various factors with the loss processes is reviewd and related to the likely magnitude of herbicide loss under various conditions. The relationship between loss processed from the terrestrial environment and the entrance and transport o herbicides in the aquatic environment is discussed.

Submitted to: (approved 08/31/89)
CHAPER IN PEST MANAGEMENT IN AGRIC.

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Technology Transfer Automated Retrieval System - (TEKTRAN)

APPARATUS FOR STUDYING PESTICIDE DISSIPATION IN THE VADOSE ZONE

ISENSEE ALLAN R

Interpretive Summary:
Pesticides must leach through the vadose zone to reach groundwater. While much is known about pesticide degradation in the surface soil, comparatively little is known about their fate in the unsaturated zone. Subsurface-soil pesticide degradation studies are generally conducted under laboratory conditions, which may differ significantly from conditions in the vadose zone such as temperature, moisture, and oxygen. The apparatus described in this paper is designed to expose soils treated with pesticides to ambient vadose zone conditions for pesticide degradation studies. The apparatus consists of a casing and enclosed vadose exposure chamber (VEC). Soil cores placed in the VEC are in equilibrium with the surrounding soil. The system was tested for 100 days by measuring oxygen at 0.5, 1, and 2 m depths and comparing results to control samplers at 1 and 2 m depths. Nearly identical oxygen concentrations indicate that the apparatus provides a treatment chamber that is in equilibrium with the soil atmosphere and is isolated from the surface atmosphere. A major advantage of the apparatus is that radiolabeled pesticides can be used because the VEC is self-sealing in the event of unexpected flooding.

Technical Abstract:
An apparatus was constructed to study pesticide degradation in situ under vadose zone conditions. The apparatus consists of a 15-cm (i.d.) casing and an enclosed vadose exposure chamber (VEC) wherein pesticide treated soil cores, placed in the VEC, are in equilibrium with the surrounding vadose zone at selected depths. Vadose zone oxygen concentrations at 0.5, 1.0, and 2.0 m were monitored over 100 days and compared to oxygen concentrations in control samplers at 1 and 2 m depths. Nearly identical oxygen concentrations indicate that apparatus provides a treatment chamber that is in equilibrium with the soil atmosphere and is isolated from the surface atmosphere. Both radiolabeled and unlabeled pesticides can be studied in the apparatus because the VEC is self-sealing in the event of unexpected flooding

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SOIL SCIENCE SOCIETY OF AMERICA

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DISSIPATION OF ALACHLOR AND ATRAZINE IN WATER AS AFFECTED BY OXYGEN LEVEL AND SOIL

ISENSEE ALLAN R

Interpretive Summary:
Pesticides have been found at low concentrations in groundwater in 34 states. In order for pesticides to reach groundwater, they must leach out of the surface soil and into the subsoil and underlying unsaturated zone. An understanding of pesticide fate in the unsaturated zone is needed to fully determine the likely magnitude of groundwater contamination. This study was designed to determine how in situ and simulated subsoil atmospheric conditions and soil affect the dissipation of alachlor and atrazine. Alachlor treated groundwater was exposed to field in situ atmospheric and temperature conditions 0, 30, and 100 cm below the soil for 56 days. Alachlor and atrazine treated groundwater were exposed (in laboratory experiments) to very low and normal oxygen levels in contact with topsoil, subsoil or no soil for 169 and 219 days. Both experiments indicated that organic carbon concentration in the system was far more important to the degradation of both alachlor and atrazine than the oxygen level or temperature. The implication of these results for groundwater pollution is that if a pesticide is transported to depths below the root zone and, thus exposed to low organic carbon levels, then persistence will be increased.

Technical Abstract:
Field and laboratory experiments were conducted to determine the effect of in situ and simulated subsoil atmospheric conditions on the dissipation of alachlor and atrazine. [ring**-14C] alachlor in filtered groundwater (0.1 PPM) was exposed to field in situ atmospheric and temperature conditions at 0, 30, and 100 cm below the soil surface for 56 days. Laboratory experiments exposed alachlor and [ring**-14C] atrazine (both in filtered groundwater at 0.1 PPM) to N2 and ambient atmosphere in contact with topsoil, subsoil or no soil for 169 and 219 days, respectively. The organic carbon concentration was more closely linked to the dissipation of both herbicides than were soil atmospheric conditions. Oxygen level affected metabolite formation, but not dissipation rate. This study suggests that pesticides that leach into the subsoil and below are likely to persist much longer than pesticides that remain in the surface soil.

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WEED SCIENCE

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EFFECT OF NO-TILLAGE VS. CONVENTIONAL TILLAGE CORN PRODUCTION ON THE MOVEMENT OF SEVERAL PESTICIDES TO SHALLOW GROUNDWATER

ISENSEE ALLAN R
NASH RALPH G
HELLING CHARLES S

Interpretive Summary:
Conservation tillage has gained wide acceptance because it greatly reduces soil erosion by decreasing water runoff increasing water infiltration. Concern has been raised that the increased water infiltration will increase pesticide leaching to groundwater. In this field study groundwater samples taken from unconfined (<1.5 m deep) and confined (<3 m deep) monitoring wells under no-till (NT) and conventional (CT) corn plots in 1986-1988 were analyzed for atrazine, cyanazine, alachlor, and carbofuran. Atrazine was found in groundwater all year while the remaining pesticides were present only for a short period (<3 months) after application. Rainfall timing relative to application was critically important to leaching. A prolonged rain immediately after the 1988 application resulted in high residues of all pesticides in both unconfined and confined groundwater and were ca. 2 to 50 times higher under NT than under CT plots. The results indicate that under "worst case" conditions, more leaching can occur under NT compared to CT practices, but rapid disappearance of peak concentrations and the shallowness of the groundwater in our study indicate that contamination of deeper groundwater is limited.

Technical Abstract:
A field site was established at Beltsville, Maryland, in 1986 to assess the effect of conventional (CT) and no-till (NT) cultural practices on the movement of pesticides into shallow groundwater. Groundwater samples taken from unconfined (<1.5 m deep) and confined (<3 m deep) monitoring wells in 1986-1988 were analyzed for atrazine, deethylatrazine, alachlor, cyanazine, and carbofuran. Atrazine was found in groundwater all year while cyanazine, alachlor, and carbofuran were present only for a short period (<3 months) after pesticide application. Fairly constant background levels of ca. <0.5 ug/L atrazine were found under fields treated before 1986 while levels under continuously treated fields were <2.0 ug/L for 22 of 25 samplings. Pesticide residues in unconfined groundwater were usually higher (ca. 2 to 4X) than in confined groundwater. Rainfall timing relative to pesticide application was critically important to pesticide leaching. A prolonged rain immediately after the 1988 application resulted in peak atrazine and cyanazine levels of ca. 200 ug/L in unconfined and ca. 30-40 ug/L in confined groundwater, which resulted in short-term levels ca. 2 to 50X greater under NT than CT plots. Results of this study suggest that preferential transport occurred.

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JOURNAL OF ENVIRONMENTAL QUALITY

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SOLID PHASE EXTRACTION OF PESTICIDES FROM WATER: POSSIBLE INTERFERENCES FROM DISSOLVED ORGANIC MATERIAL

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FENDINGER NICHOLAS J
PLIMMER JACK R

Interpretive Summary:
In this study a multi-residue method of extraction and analysis for thirteen pesticides in water was developed which utilized solid phase extraction (SPE) technology. Typically liquid/liquid partitioning (LLP) techniques are used to extract organic contaminants from water. SPE has several advantages over LLP including: decreased exposure to hazardous solvents; decreased waste disposal costs; potential for automation; and extractions unhindered by the formation of emulsions. The thirteen pesticides, trifluralin, simazine, atrazine, propazine, diazinon, parathion-methyl, alachlor, malathion, parathion, chlorpyrifos, pendimethalin, methidathion, and DEF, were identified and quantitated by gas chromatography/mass spectroscopy. The influence of dissolved organic matter (DOM) on extraction efficiency was studied by comparing pesticide recovery from three types of water samples, distilled water, distilled water, distilled water containing Aldrich humic acid, and a natural river water. Water samples containing DOM gave lower recoveries for all pesticides in the Aldrich humic acid solution and 4 of the pesticides in the natural river water. Experiments with 14c-labelled diazinon and parathion confirmed that pesticide not recovered from the SPE column was found in the eluted water suggesting the formation of a pesticide-humic acid complex. Such a complex has been theorized as a possible transport mechanism for pesticides reaching groundwater. Environmental analysts who seek to quantitate pesticides and other organic contaminants in natural waters by SPE techniques are advised that reduced recoveries may result in samples containing DOM. Therefore they are encourage to use field spikes of surrogate compounds to account for potentially reduced recoveries.

Technical Abstract:
A multi-residue analysis for trifluralin, simazine, atrazine, propazine, diazinon, parathion-methyl, alachlor, malathion, parathion, chlorpyrifos, pendimethalin, methidathion, and DEF in water that utilizes solid phase extraction (SPE) with octadecyl modified silica followed by gas chromatography/mass spectrometric analysis was developed. Quantitative recoveries of all pesticides were obtained with SPE from fortified water at concentration levels from about 1 ppb to 500 ppb. Recovery of most pesticides with SPE, from an optically adjusted humic acid solution (10 ppm dissolved organic carbon) made to simulate a natural water with a high dissolved organic content, averaged 30% lower. 14C-Labeled diazinon and parathion were recovered from the humic acid solution at levels of 57% and 68%, respectively, with Sep-Pak cartridges; the remainder of the labeled pesticides was found in the column eluents. Partition coefficients with humic acid were calculated based on recovery of 14C labeled pesticides from the Sep-Pak cartridges.

Submitted to: (approved 09/12/90)
ANALYTICAL CHEMISTRY

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TREATMENT OF PESTICIDE WASTES WITH MICROBIAL PESTICIDE HYDROLASES

KARNS JEFFREY S
SOMICH CATHLEEN J

Interpretive Summary:
Disposal of waste pesticide solutions is an area of growing concern for the agricultural community. Cattle-dipping operations overseen by the Animal and Plant Health Inspection Service (APHIS) annually generate several thousand gallons of waste containing high levels of the insecticide coumaphos. Coumaphos is a very long-lived compound in soils. A method has been developed that uses the enzyme parathion hydrolase to cleave the coumaphos molecule into products that are readily destroyed by ozone. Parathion hydrolase completely hydrolyzed the coumaphos in waste cattle-dip in 48 hours. Upon treatment with ozone, the products of the enzymatic hydrolysis were destroyed within 10 hours. These experiments demonstrate the feasibility of combining biological and physical treatments for the effective disposal of waste cattle-dips. These experiments also indicated that it may be possible to use parathion hydrolase to extend the useful lifetime of coumaphos containing dipping solutions by selectively degrading the toxic contaminant potasan from the vats.

Technical Abstract:
Use of the insecticide and acaricide coumaphos (0,0-diethyl 0-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7yl) phosphorothioate) to control ectoparasites on cattle in the southern United States generates large volumes of waste waters containing high levels of active ingredient. A process has been developed that uses microbially produced parathion hydrolase to hydrolyze the coumaphos molecule yielding products that are amenable to further destruction by treatment with ozone. Parathion hydrolase preparations from Flavobacterium or from recombinant Streptomyces lividans and Escherichia coli containing a cloned opd gene from Flavobacterium were effective in coumaphos hydrolysis. The rate of coumaphos hydrolysis was influenced by the non-ionic detergent Tween 80 and by the concentration of cobalt ions in the reaction mixture. In a small scale test, 76 liters of waste cattle dip was successfully treated by hydrolysis with a parathion hydrolase followed by ozonation. Ozonolysis of the hydrolysis products followed pseudo-first order kinetics.

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BIOTECHNOLOGY PROGRESS

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PROGRESS TOWARD IDENTIFYING PTTH(S) AND PTTH GENE(S) OF THE GYPSY MOTH, LYMANTRIA DISPAR (L.)

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MASLER EDWARD P
BELL ROBERT A
THYAGARAJA BELGAUM S
DAVIS ROBIN E
FESCEMYER HOWARD W
BORKOVEC ALEXEJ B

Interpretive Summary:
The need for environmentally compatible pest control agents that will alleviate contamination of groundwater and food supplies by chemical pesticides continues to grow. Biological agents that interfere with insect neuropeptide synthesis or action could provide such environmentally compatible pest control. We have developed methods for the isolation of one family of insect neuropeptides and its genes, the prothoracicatropic hormones (PTTHs), that regulate growth and development in insects. With the gypsy moth, a noxious pest of forests and urban areas, we have partially purified PTTHs from various stages, egg through adult, and produced gene fragments to at least one PTTH form. The amino acid and nucleic acid sequence information eventually obtained from these studies will be valuable in developing engineered biological control agents useful in insect pest control.

Technical Abstract:
The processes of molting and metamorphosis in insects are regulated by a neuropeptide, prothoracicotropic hormone (PTTH) that acts through the stimulation of ecdysteroid synthesis and secretion by the prothoracic glands. PTTH exists in various insect species as a family of peptides comprised of two major classes that fall within the following mass ranges: large PTTH, 11-27 kD; small PTTH, 4-7 kD. In the gypsy moth, Lymantria dispar, we estimate ranges of 11-15 kD and 4-6 kD for large and small PTTH, respectively, from both larval and pupal brains. PTTH activity, with a molecular mass of <5 kD, has also been demonstrated in extracts of whole, pre-hatch L. dispar eggs. Small PTTH-specific nucleotide sequences have been amplified from L. dispar cDNA by the polymerase chain raction (PCR), and fragments of the expected size have been obtained. The development of bioassays for L. dispar PTTH and recent work on PTTH in other insect species are discussed.

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ACS BOOKS

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Technology Transfer Automated Retrieval System - (TEKTRAN)

SIMULATION OF ONE-DIMENSIONAL NITRATE TRANSPORT THROUGH SOIL AND CONCOMITANT NITRATE DIMINUTION

KUNISHI HARRY M
SADEGHI ALI M

Interpretive Summary:
The purpose of this study was to conduct prototype leaching experiments with one small, intact soil core to obtain information on the transport of nitrate in the presence and absence of a carbon source capable of supporting microbial growth. The size of the soil core selected was small enough to be readily extricated from the field, but large enough to preclude wall effects. Our soil core sample was taken from a riparian zone (RZ). Information obtained from the leaching experiments were used in a model by Parker and van Genuchten (1984) for solute transport and rates of solute decay and production during one-dimensional flow. This model accounted for experimentally determined transport and loss of nitrate. The model also provided transport parameter values for dispersion coefficient, nitrate exclusion factor, and a nitrate decay rate constant. Field managers who seek to optimize nitrate diminution in RZ's can use this approach to characterize nitrate transport characteristics in specific locations within an RZ before and after imposing management practices designed to increase the effectiveness of RZ's to lower the transport of nitrate. Other scientists can use this approach to obtain transport parameter values applicable to field dimensions by pooling information obtained from many such cores.

Technical Abstract:
A small core of intact soil provided information about the lateral transport and diminution of nitrate in the presence and absence of a carbon source capable of supporting microbial growth. The core (6.2 cm in diameter by 15 cm in length) was obtained by pushing a plastic cylinder horizontally into the wall of a trench excavated in a riparian zone where water moves laterally. Under conditions favorable for nitrate diminution, pulses of nitrate solution containing carbon were passed through the core and leached with water. Effluents were collected at fixed intervals and analyzed. Nitrate losses ranged from 4% to 72%, presumably via denitrification. Effluent nitrate concentrations and pore water velocities were entered into a model developed by Parker and van Genuchten for one-dimensional convective-dispersive solute transport and for solute decay and production. The model accounted for the experimentally determined transport and loss of nitrate (R^2 = 0.99). The model also provided values for dispersion coefficient, nitrate exclusion factor, and nitrate decay rate constant. Nitrate loss was reasonably accounted for by a decay rate constant (avg. = 2.21/day) that increased as observed nitrate loss increased. A sizable factor for anion exclusion and/or the presence of immobile-water regions was necessary to account for the rapid passage of nitrate through the soil core. Peclet numbers, which are inversely related to dispersion coefficient, were low. These low numbers and a retardation factor of less that 1 suggested that the flow through the soil core may have been heterogeneous.

Submitted to: (approved 09/06/90)
SOIL SCIENCE
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MEASURING PESTICIDE DISTRIBUTION USING CONDUCTIVITY OF TRACER ELECTROLYTE

LILJEDAHL LOUIS A
FISHER G T

Interpretive Summary:
Measuring the distribution of material dispersed by pesticide application equipment is necessary to evaluate the effects of design and environmental variables on performance of the equipment, as well as to permit the variables on performance of the equipment, as well as to permit the operator to adjust the equipment properly. Because there is usually much variation in these measurements, a large number of measurements are needed to get reliable results. Since measurement of pesticide chemicals themselves is usually too laborious, for many years the most common practice has been to add an easily measured tracer material, such as a dye or fluorescent material and measure its distribution instead of the pesticide. This study shows that this approach can be simplified still further by simply using a conductive electrolyte as a tracer, and measuring the conductivity of dissolved material. Furthermore, strips of 35 mm leader film used for processing 35 mm movie film can be used as simple collecting surface to measure distribution of sprayers in the field, and by washing off the electrolyte in a washing cell designed to have small volume and quick washing time, fine scale variation of pesticide distribution could be easily detected and measured. Proper care must be exercised to be certain that the added electrolyte does not change the properties of the pesticide used.

Technical Abstract:
Swathwise distribution of pesticide from a ground sprayer was measured by adding electrolyte salt solution to the liquid being sprayed and collecting the spray deposit on the ground with a transect of 35 mm wide polyester film. When the deposit was dry, the film was passed through a small cell which washed off deposit and measured the conductivity of the wash solution. The method appears to be capable of sensing variations of deposit over short distances and, because of its simplicity, may be suitable for many field measurements of pesticide distribution.

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TRANSACTIONS AM. SOC. AG. ENGINEERS
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A SIMPLIFIED HIGH PERFORMANCE LIQUID CHROMATOGRAPHY METHOD FOR THE SIMULTANEOUS ANALYSIS OF TEBUTHIURON AND HEXAZINONE

LYDON JOHN
ENGELKE BEATRIZ F
HELLING CHARLES S

Interpretive Summary:
This report describes a simplified, high-performance liquid chromatographic (HPLC) method for the simultaneous measurement of residues of the herbicides tebuthiuron and hexazinone in soil and plant tissues. The method is superior to previously published HPLC methods for the analysis of these compounds.

Technical Abstract:
A simplified, high-performance liquid chromatographic (HPLC) method for the simultaneous measurement of the herbicides tebuthiuron and hexazinone was developed. Separation was achieved on a NOVA-PAK phenyl, 4 um, 8 mm x 10 cm column with methanol-water (50:50) as eluant and on-line detection at 254 nm for tebuthiuron and 249 nm for hexazinone. At a flow rate of 2.5 ml min-1, the retention times were approximately 4.5 and 6.3 min. for tebuthiuron and hexazinone, respectively. The procedure was used successfully for the analysis of residues of these herbicides in soil and plant tissues. A comparison with published procedures for the individual analysis of tebuthiuron and hexazinone is presented.

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J CHROMATOGRAPHY

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A COMPARISON OF THE AERODYNAMIC AND THE THEORETICAL-PROFILE-SHAPE METHOD FOR MEASURING PESTICIDE EVAPORATION FROM SOIL.

MAJEWSKI M. S
GLOTFELTY D. E
SEIBER J. N

Interpretive Summary:
Pesticides, while being considered non-volatile organic compounds, are being detected in increasing numbers in the ambient air that we breath. As public concern for the issue of toxic compounds in the air grows, state and federal governments may require knowledge of how much and how fast an applied pesticide evaporates into the atmosphere. There are several existing procedures for experimentally measuring the post-application volatilization, or flux, of pesticides but these methods are very expensive in terms of required land area, chemical used, man power, and monetary outlay. These experiments also generate a tremendous volume of samples which have to be analyzed before the final answers can be obtained. The interpretation of the results may take from several months to more than one year. This study compared one of the most often used flux determination methods, the aerodynamic method using the Thornthwaite-Holzman equation (TH) to a dramatically simpler technique called the Theoretical-Profile-Shape (TPS) method. The TPS method requires approximately one tenth as much land area as the TH method and generates one fifth of the samples needed for a final answer. We found that the flux values generated using the TPS method were not statistically different than those from the TH method.

Technical Abstract:
The theoretical-profile-shape (TPS) method for measuring the volatilization flux of four pesticides from fallow soil was found to provide results which were not statistically different from the aerodynamic method using the Thornthwaite-Holzman (TH) equations. This result was from a side-by-side field comparison using the two methods. The aerodynamic field experiment required one hectare of uniformly surfaced land area, detailed gradient measurements of horizontal wind speed at four heights above the surface, temperature at three heights, and pesticide air concentration at five heights. In contrast, the TPS method required a circular plot (r = 20m) of ~0.1 hectare and a single measurement of wind speed and pesticide air concentration at a predetermined height above the treated surface. These results indicate that the simpler TPS method can be reliably used to determine evaporative fluxes for compounds with low vapor pressures (<10**-2 Pa) with more rapid final flux determinations and reduced expense.

Submitted to: (approved 05/24/89)

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EVALUATION OF THE PRE-SIDE DRESS NITRATE SOIL TEST IN MARYLAND

MEISINGER JOHN J
BANDEL V A, ANGLE, J S, O'KEEFE, B E, REYNOLDS, C M

Interpretive Summary:
Society is concerned about nitrate enrichment of groundwater and estuaries. The agriculture community shares this concern and is actively researching ways to improve nitrogen use efficiency. A basic tool to increase nitrogen efficiency is a nitrogen soil test. A nitrogen soil test for corn was evaluated in Maryland which measures the nitrate nitrogen concentration in the top foot of soil when the corn is 6-12 inches tall i.e., about two weeks before planned sidedressing. The test was evaluated on research farm experiments over a wide range of soils and over several growing seasons. These tests studied the effects of various tillage systems, applications of manure or composted sludge, winter cover crops, and applications of fertilizer. The results show that the soil test can identify nitrogen sufficient sites, i.e. sites needing little or no sidedress fertilizer nitrogen. Nitrogen sufficient sites contained greater than 22 parts per million nitrate nitrogen and were usually associated with previous inputs of manure or composted sludge, or had grown a legume cover crop. The test will help nutrient consultants, extension agents, and farmers identify nitrogen sufficient sites and thereby: conserve fertilizer nitrogen, improve nitrogen use efficiency, and reduce nitrate losses to the environment.

Technical Abstract:
Nitrate enrichment of groundwater and estuaries is a major concern in the Mid-Atlantic States. The pre-sidedress nitrate test (PSNT) was evaluated for corn in Maryland by collecting 0-30 cm soil samples when the corn (Zea mays L.)was 15-30 cm tall, determining NO3-N and (NO3+NH4)-N by steam distillation, and measuring corn grain yield. The replicated research farm experiments were located in both the Piedmont and Atlantic Coastal Plain regions and included 7 soil types and 5 growing seasons. A total of 47 treatment-year combinations were studied including variables of tillage, organic amendments, cover crops, and fertilizer N rates. The PSNT accurately reflected differences in N availability to corn due to prior manure applications (poultry manure or dairy manure), prior composted sludge applications, and prior N inputs from incorporated winter cover crops. The PSNT can be used on either no-tillage or plow-tillage systems. Soil NO3-N concentrations greater than 22 mg/kg soil, or (NO3+NH4)-N concentrations greater than 27 mg/kg soil, were associated with relative yields of 95% or higher. At soil N concentrations less than the above values the variation in relative yield was considered to be too large to use the test for quantitative prediction. The PSNT successfully identified N sufficient sites across a range of soil textures and drainage classes. By identifying N sufficient sites, the PSNT will help farmers conserve fertilizer N and reduce NO3-N losses to the environment.

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SOIL SCIENCE

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Technology Transfer Automated Retrieval System - (TEKTRAN)

HARVEST MANAGEMENT OF LEGUME COVER CROPS FOR NO-TILLAGE CORN PRODUCTION

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HOLDERBAUM JAMES F, DECKER, ALFRED M, MULFORD, RONALD F, VOUGH, LESTER R

Interpretive Summary:
The nitrogen nutrition of modern cereal crop production systems has been satisfied primarily through fertilizer applications. However legume cover crops could possibly be utilized in modern farm enterprises as nitrogen sources for the suceeding crop or as sources of forage for livestock. We conducted field experiments in 1983 through 1986 in the Coastal Plain region of Maryland to evaluate crimson clover harvest management systems including no cover crop harvest, spring silage harvest and simulated spring grazing of the cover crop. Following the above harvest management treatments no-tillage corn was planted and fertilized with either 80lbs. of nitrogen per acre or no fertilizer nitrogen. Data was collected on corn grain yield, total nitrogen content, and forage production of the corn and cover crop. This data showed that the greatest corn yields and nitrogen uptake occurred when the cover crop was not harvested. However, the greatest total silage production occurred when both the corn and cover crop were harvested for forage. These results sugest that a crimson clover cover crop can add flexability to a farm enterprise because it can be utilized either as a nitrogen source for a succeeding corn crop or as a high protein forage in a livestock production system.

Technical Abstract:
Legume cover crops are frequently used as N sources for corn (Zea mays L.), however, little research has been done on management options for legume covers. Field studies were conducted on a Coastal Plain Matapeake silt loam soil from 1983-1986 with the objectives of assessing cover crop harvest management schedules on: i) total N of legume cover crops; ii) subsequeny corn grain and silage yields; and iii) combined cover crop and corn forage production. A crimson clover (Trifolium incarnatum L.) cover crop was subjected to no-harvest (NH); spring silage harvest with clippings removed (SS); and simulated pasture harvests with clippings from multiple harvests removed (PV) or returned (PT). No-tillage corn was grown in the cover crop residues and received fertilizer nitrogen (FN) treatments of 0 and 90 kg N ha-1. Multiple harvests (PV) of the cover crop resulted in lower average cover crop herbage yields (2.98 Mg ha-1) and total N content (114 kg ha-1) than for a single harvest (SS) (4.70 and 146, respectively). Corn grain yields, grain plus fodder yields, and corn N uptake were generally higher when the cover was left in place (NH or PT) than when removed. The greatest total silage production occurred when both cover crop and corn were harvested for forage. These results suggest several harvest management options of a legume cover crop which offer flexibility in optimizing subsequent corn grain yields or total forage production.

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AGRONOMY JOURNAL

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Technology Transfer Automated Retrieval System - (TEKTRAN)

ESTIMATING N BUDGETS FOR SOIL-CROP SYSTEMS.

MEISINGER J. J
RANDALL G. W

Interpretive Summary:
Nitrate losses from agriculture into groundwater are a continuing concern for society. The agricultural community must begin to reduce these losses in order to be good stewards of our soil and water resources, to respond to societies' expectations, and to improve N use efficiency. Leaching losses are usually greatest at sites which receive excess N inputs. Identifying these N rich sites has usually required well monitoring or soil sampling over extensive areas. This work has developed an "N screening model" which will identify N rich sites by estimating field scale N budgets. The budgets are developed by inventorying the managed N components (fertilizers or manure inputs and crop removals) and by estimating the non-managed components (denitrification, ammonia loss, etc.) through soil properties and average climatic data. This model will qualitatively identify N rich sites in order to help county extension agents and SCS agents (1) define areas for further sampling to quantify the extent of the nitrate problem, and (2) define areas where extension education programs could be implemented to reduce the risk of nitrate enrichment of groundwater.

Technical Abstract:
Nitrate N losses from agriculture into groundwater are a continuing concern for society. Leaching losses are usually greatest at sites which receive excess N inputs. This chapter reviewed N budget concepts and describes a "N-screening" model which is aimed at estimating field scale N budgets. These budgets are estimated by inventorying the managed N components (fertilizer or manure inputs and crop removals) and by estimating the non-managed N components (denitrification, ammonia loss, etc.) through soil properties and average climatic data. The objective of such budgets is to rapidly and qualitatively identify N rich sites where nitrate losses to groundwater may be significant. Such N rich sites could be sampled to quantify the extent of the nitrate problem or they could define areas where education programs should be implemented to reduce the risk of nitrate enrichment of groundwater.

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BOOK/H.BOOK CHAPTER BY ARS: "MANAGING N

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Technology Transfer Automated Retrieval System - (TEKTRAN)

USING WINTER COVER CROPS TO RECYCLE NITROGEN AND REDUCE LEACHING

MEISINGER JOHN J
SHIPLEY PAUL R
DECKER A MORRIS

Interpretive Summary:
Farmers face a difficult task as they seek to balance the competing goals of maintaining farm profitability, by ensuring an adequate supply of N to the crop, yet avoiding excessive N rates that could degrade groundwater quality. Both legumes and grasses have been utilized in the Southeast as winter cover crops but their ability to recycle corn fertilizer N has not been evaluated. We directly measured the ability of grass (cereal rye and ryegrass) vs, legumes (hairy vetch and crimson clover) to recycle corn fertilizer N by adding isotopically tagged fertilizer to corn and measuring the uptake of the corn fertilizer by the covers. Our field results show that grasses are clearly superior to legumes in retaining corn fertilizer N with grasses taking up 50-60% of the excess fertilizer (in tops plus roots) while legumes took up less than 10%. These field results agree very well with earlier lysimeter results which also showed that grasses were superior to legumes at conserving N. The use of grass winter cover crops is an old practice which should be re-incorporated into modern cropping systems.

Technical Abstract:
Winter cover crops are a management practice which can reduce nitrate leaching by i) utilizing water for growth and thereby reduce percolation, and ii) absorbing N to meet nutritional needs. Both legumes and grasses are utilized as cover crops in the Southeast but their ability to recycle fertilizer N in the field has not been evaluated. We directly measured the ability of grass vs. legume cover crops to retain corn fertilizer N by adding 15N labelled fertilizer to corn, subsequently growing grass and legume covers, and measuring the uptake of the corn fertilizer N by the covers. We found that grasses (cereal rye and ryegrass) retained 50-60% of the corn fertilizer N in their tops plus roots, while legumes (hairy vetch and crimson clover) retained 10% or less. These recent field results agree with earlier lysimeter results in the Southeast which shows that nitrate leaching with grasses was reduced 75-85% compared to the no-cover controls, while the corresponding value for legumes was 0-12%. Agriculture scientists should therefore place greater emphasis on incorporating grass cover crops into modern cropping systems.

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1990 SOUTHERN CONSERVATION TILLAGE CONFERENCE

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CONTROL OF THE MUSHROOM FLY, LYCORIELLA MALI BY THE INSECT PARASITIC NEMATODE STEINERNEMA FELTIAE (=BIBIONIS)

NICKLE WILLIAM R
CANTELO WILLIAM W

Interpretive Summary:
The sciarid fly, Lycoriella mali is a serious pest of commercial mushroom growing in the United States. The larvae of this fly destroy the mushroom mycelium and tunnel through the caps and stems of the mushrooms. This paper is the first report on the use of steinernema nematodes to control mushroom flies in the United States. The highest rate of control, 85% was achieved when nematodes were added to the container at the rate of 620 per square centimeter. New safe biological controls would be welcomed by the mushroom industry for socioeconomic reasons. Mushroom flies have developed some resistance to insecticides and pesticide residues from discarded compost may find their way to groundwater. These treatments, with the nematode ecological control agent, significantly suppressed fly populations and showed a promise as a biocontrol agent of the mushroom fly.

Technical Abstract:
The sciarid fly, Lycoriella mali, is a serious pest of commercial mushroom growing in the United States. The larvae of this fly destroy the mushroom mycelium and tunnel through the caps and stems of the mushrooms. This paper is the first report on the use of steinernematid nematodes to control mushroom flies in the United States. Laboratory studies showed that this sciarid fly was susceptible to parasitism by the steinernematid nematode, Steinernema feltiae (=bibionis). The moist compost is an excellent environment for the nematodes. Containers of mushroom compost, each of which contained 100 or 200 fly eggs, were drenched with varying numbers of infective stage nematodes. Time of application was studied and results showed that the highest control was achieved when the nematodes were added while the insect was in the third larval instar. The highest rate of reduction, 85% was achieved when nematodes were added to the container at the rate of 620 per cm2. The nematodes migrated quickly throughout the compost. These treatments significantly suppressed fly populations and showed promise as a biocontrol agent of the mushroom fly.

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JOURNAL OF NEMATOLOGY

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Technology Transfer Automated Retrieval System - (TEKTRAN)

RAINFALL DISTRIBUTION UNDER A CORN CANOPY: IMPLICATIONS FOR MANAGING AGROCHEMICALS

PARKIN TIMOTHY B
CODLING ETON E

Interpretive Summary:
Recent concerns over groundwater and surface water pollution demand that current agricultural practices be modified to reduce leaching and runoff of agrochemicals. This will require greater knowledge of the spatial patterns of water inputs to the soil surface. Our study was initiated to investigate the influence of corn plants on the rainfall distribution at the soil surface. It was found that corn plants have the ability to intercept and channel substantial amounts of rainwater down the stalk. Results obtained from 8 storm events in 1987 revealed that corn plants channel 23% to 47% of the tatal rain inputs down the stem to the base of the stalk. This stemflow plus the rainfall impinging directly in the planting furrow, accounted for approximately 46% of the total water inputs from a given storm event. These increased water inputs to the planting furrow may have implications in modeling solute leaching and runoff as well as to modifying current fertilizer and pesticide application methods.

Technical Abstract:
Recent concerns over groundwater and surface water pollution demand that current agricultural practices be modified to reduce leaching and runoff of agrochemicals. This study was initiated to investigate the process of stemflow, and to provide quantitative data on the distribution of rainfall under a corn canopy. Rainfall distribution under the canopies of replicate conventional till corn plots was investigated by placing rainfall collectors at discrete locations within small 1.6 m x 0.76 m areas of the plots. The rainfall collectors were placed down the center line between two adjacent corn rows, along two lines offset 19 cm on either side of the center line, and in the corn rows between corn plants. In addition, collection cups were also fixed around the stalks of individual corn plants to quantify stemflow. Results obtained from 8 storm events in 1987 revealed that corn plants channel 23% to 47% of the total rain inputs down the stem to the base of the stalk. This stemflow plus the rainfall impinging directly in the planting furrow, accounted for approximately 46% of the total water inputs from a given storm event. These increased water inputs to the planting furrow may have implications in modeling solute leaching and runoff as well as to modifying current agrochemical application methods.

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AGRONOMY JOURNAL

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Technology Transfer Automated Retrieval System - (TEKTRAN)

EVALUATION OF METHODS FOR CHARACTERIZING CARBOFURAN HYDROLYSIS IN SOIL

PARKIN TIMOTHY B
SHELTON D R
ROBINSON J A

Interpretive Summary:
Recent concerns over groundwater and surface water pollution has demanded that current agricultural practices be modified. Effective mitigation of the environmental consequences of pesticide application to agricultural lands, either through modification of agricultural management practices or pesticide formulations, will require an increased quantification of the fate of pesticides applied to soils. Degradation by microorganisms has been documented as a predominant fate of pesticides in soil; however, efforts to precisely quantify and/or predict pesticide degradation rates is hampered by high spatial and temporal variability associated with microbial processes in nature. The objective of this work was to design and evaluate a protocol for assessing pesticide degradation rates in soil, using the insecticide, carborfuran, as a model compound. Two factors were considered in the methods development: i) the mode of soil handling and pesticide application, and ii) the method of data summarization.

Technical Abstract:
The objective of this study was to develop a method to investigate the soil/environmental factors influencing the spatial and temporal variability of carbofuran hydrolysis in field soils. Three soil treatment modes were evaluated: i) sieved soil/sprayed pesticide application, ii) injected pesticide application/sieved soil, and iii) injected pesticide application/intact core incubation. This last method was developed to more closely mimic field condition in which high localized concentrations of carbofuran occur due to the banding of granular material at planting time. Several mathematical models for describing sigmoidal product appearance data were evaluated and a general saturation model was found to yield the best fit. Using parameter estimates obtained from this model in statistical tests were found that the intact core soil treatment yielded significantly longer half lives for carbofuran degradation. Additional experimental evidence suggests that the soil structure of the intact cores retarded diffusion of the 14CO2 produced from carbofuran degradation which influenced the kinetic pattern observed.

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SOIL SCIENCE SOCIETY OF AMERICA JOURNAL

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CONTAMINATION OF GROUNDWATER BY ATRAZINE AND SELECTED METABOLITES

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Interpretive Summary:
The widespread use of atrazine and its conversion to a metabolite (DEA) that is more persistent, more leachable and as phytotoxic has raised concerns regarding groundwater contamination. We show widespread contamination, but at very low concentrations which suggest little environmental impact. However, the contamination patterns in time and space, and their stability in the more contaminated well waters, suggest that degradation rates, leaching rates and the atrazine/DEA storage together control the DEA concentrations in groundwater. Dilution, usually dominant in groundwater systems, has little affect. Thus, the atrazine-metabolite relationships developed here for soil-groundwater indicate this to be a useful model for examining the behavior and patterns of other pesticides/metabolite combinations as they move from soil to groundwater to stream baseflow.

Technical Abstract:
Groundwaters from an agricultural PA watershed were analyzed for atrazine, cyanazine, simazine, and the desethylated (DEA), and desisopropylated (DIA) atrazine metabolites. Atrazine and both metabolites were found in most groundwaters including deep wells, a spring and groundwaters about to become streamflow. The highest concentrations of atrazine and the dominant metabolite, DEA, were found in groundwaters draining areas dominated by corn production, especially after the first major groundwater recharge period following herbicide application.

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Technology Transfer Automated Retrieval System - (TEKTRAN)

INLET/OUTLET DESIGN FOR HORIZONTAL WATER AND SOLUTE MOVEMENT IN A LABORATORY SCALE CHAMBER

SADEGHI A. M
STARR J. L

Interpretive Summary:
A laboratory-scale chamber was used to develop a proper inlet/outlet (I/O) arrangement for eventual application to a field-scale stainless steel chamber for monitoring the transport and transformation of agrochemicals in laterally moving shallow groundwater. This chamber was constructed of plexiglass and filled with fine sand. Two I/O designs (single-port and multi-port) were evaluated by observing Cl breakthrough curves of the leachate, following a pulse application in the saturated zones at the inlet. Comparison of the data with a one dimensional reaction-transport model shows the I/O design with equally spaced ports was most satisfactory. Results from both designs will be presented and discussed.

Technical Abstract:
Riparian zones (wetlands) are believed to have a major role in reducing the level of agrochemicals as they move through such zones. We have initiated a groundwater research program by concentrating on the establishment of an isolated riparian zone (IRZ) as a tool for measuring amounts and transformations of agrochemicals (e.g. nitrate) in laterally moving shallow groundwater. To accomplish this objective the first requirement was to design, build, and test a laboratory-scale IRZ chamber with an inlet/outlet (I/O) arrangement, at opposite ends of the chamber, that produces minimal disturbance in the horizontal flow pattern of water and solute. Consequently, a plexiglass chamber was constructed and filled with fine sand. Two I/O designs were evaluated by comparing the measured Cl- effluent concentrations obtained from each design with the computer Cl- concentrations using a one-dimensional solute transport model. Results show that the I/O arrangement with equally spaced ports as opposed to the single-port was most satisfactory.

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JOURNAL OF ENV. QUALITY

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EVALUATION OF A TWO DIMENSIONAL HORIZONTAL FLOW SYSTEM

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Interpretive Summary:
Field studies have shown that concentrations of agricultural chemicals are reduced significantly as the chemicals move laterally from the edge of the field through riparian zones to nearby streams and estuaries. A laboratory-scale chamber was designed and tested as a prototype for constructing a larger field-scale chamber to characterize in-situ levels and transformations of agrichemicals within the riperiam zone areas. The multi-port injection technique that we have developed and tested in these studies promises to provide a useful experimental technique as a preliminary to studying horizontal flow processes in field.

Technical Abstract:
Results of several field studies have shown that a significant reduction in concentration of agricultural chemicals(agrichemicals) occurs as they move laterally from the edge of the field through riparian zones (RZ) to nearby streams, estuaries, etc. A laboratory-scale chamber was designed and tested as a prototype for constructing a larger field-scale chamber to characterize in-situ levels and transformations of agrichemicals within the RZ areas. The chamber was made of plexiglas with dimensions of 1.2 by 0.6 by 0.3 m and filled with fine sand. A multi-port arrangement (6 rows and 12 columns of 1-cm diameter holes) on both end walls of the chamber provided a plate-like combination for uniform solute application at the inlet side and allowed sampling from all ports at one time at the outlet side. An equilibrium-base convection-dispersion model was applied to the Cl breakthrough data of each of the 50 outlet ports in order to visualize the 2-dimensional distribution of pore water velocity (V) and dispersion coefficient (D) values at the outlet plate. The spatial variability of V and D were attributed to the heterogeneity in the packing process, evaporation losses from the sand surface, and density difference of the miscible displacement solutions.

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SOIL SCIENCE SOCIETY OF AMERICA JOURNAL

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Technology Transfer Automated Retrieval System - (TEKTRAN)

COMPARISON OF VARIOUS WINTER COVER CROPS' ABILITY TO RECYCLE CORN FERTILIZER NITROGEN IN MARYLAND

SHIPLEY PAUL R & DECKER, A MORRIS
MEISINGER JOHN J

Interpretive Summary:
Grasses are about four times as efficient as legumes at recycling excess nitrogen fertilizer. Excess nitrate from fertilizers can leach down to groundwater and become a pollutant. One way farmers try to avoid this problem is by planting a crop in late fall that will use up any nitrate not used by the last crop. The question then becomes: Which crops are best to use as winter cover crops? For a clear--if regional--answer, Agricultural Research Service scientists used an ammonium nitrate fertilizer that was tagged with N-15, an isotopic form of nitrogen that is found only in minute quantities in nature or in commercial fertilizer. At a University of Maryland research farm on Maryland's Eastern Shore, ARS soil scientist J. J. Meisinger and graduate student Paul Shipley applied the tagged fertilizer to corn for 2 years. Each fall they measured the residual tagged nitrogen in the soil to 2 feet and planted cover crops of cereal rye, ryegrass, hairy vetch, and crimson clover. The next spring the cover crops were harvested, ground, and analyzed for N-15. Any N-15 found could come only from the previous corn fertilizer. Considering only the aboveground nitrogen uptake, they found cereal rye and ryegrass were the best winter cover crops by far. Each took in about 40 percent of the fall residual nitrate. The hairy vetch and crimson clover legumes each took up only about 10 percent.

Technical Abstract:
Autumn residual fertilizer nitrogen (FN) is vulnerable to leaching loss in humid areas and represents a wasted resource and a potential pollutant. Legume and grass winter cover crops were evaluated for their ability to assimilate residual FN as a means of reducing leaching after corn. Labelled FN (15N depleted) was applied to corn in 1986 and 1987 at rates of 0, 168 and 336 kg N/ha. After corn harvest cover crops of, hairy vetch (Vicia villosa Roth), crimson clover (T. incarnatum L.), cereal rye (Secale cereal L.), annual ryegrass (Lolium multiflorum) or native weeds were established. Harvests were made three times the following spring; dry matter yields, %N, and atom % 15N were determined to assess FN uptake. Average FN uptake over the 2 years by the cereal rye, annual ryegrass, hairy vetch, crimson clover and native weed cover on the 168 kg N/ha treatment was 11, 6, 3, 4 and 2 kg N/ha respectively, at the second harvest (mid April). Corresponding FN uptake on plots previously fertilized with 336 kg N/ha were 48, 29, 9, 8 and 6 kg N/ha (L.S.D. 0.05=7 kg FN/ha). Fall FN levels in the soil averaged 17 and 114 kg N/ha over both years for the 168 and 336 kg N/ha rates, respectively. These results indicate that with high residual N the grass cover crops conserved the most FN, with cereal rye being the most efficient recycler through mid-April.

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AGRONOMY JOURNAL

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ATRAZINE AND BROMIDE MOVEMENT THROUGH A SILT LOAM SOIL

STARR J. L
GLOTFELTY D. E

Interpretive Summary:
Movement of agrochemicals through soil to groundwater is affected by soil condition, soil management, & timing of leaching events following application to the soil surface. This study was conducted to determine the rate of movement of Bromide (a tracer for nitrate-N) & atrazine (a herbicide) through a field soil as affected by conventional- and minimum-till corn. The soil surface inside double ring infiltrometers was sprayed with the chemicals & one week later 10 cm of solution was applied under ponded flow conditions. One day after ponding, the soil was intensively sampled to a depth of about 30 inches and analyzed for water content & for concentrations of bromide & atrazine. Distribution patterns of Br & atrazine with soil depth were quite similar-with the largest proportion of the chemicals observed in the surface horizon, yet all cores showed some movement of chemicals to the deepest sampling depth (90 cm). However, on average less than 50% of the applied water & chemicals could be found. Two quite different processes seem to be involved in the movement of these chemicals through this soil: one-dimensional movement through the soil matrix; & rapid downward movement through macropores-by-passing most of the soil matrix. These findings have major implications regarding the potential for contamination of groundwater by agrochemicals.

Technical Abstract:
Movement of agrochemicals through soil to groundwater is affected by soil condition, soil management, & timing of leaching events following application to the soil surface. This study was conducted to determine the pattern(s) of movement of Br & atrazine through a field soil as affected by conventional- and minimum-till corn (Zea mays L.) under severe leaching conditions. The soil surface inside double ring infiltrometers was sprayed with chemicals & one week later 10 cm of solution was applied under ponded flow conditions & soil cores removed the next day for chemical analysis. Distribution patterns of Br & atrazine with soil depth were quite similar-with the largest proportion of the chemicals observed in the surface horizon, yet all cores showed some movement of chemicals to the deepest sampling depth (90 cm). However, on average less than 50% of the applied water & chemicals could be found. Two quite different processes seem to be involved in the movement of these chemicals through this soil: one-dimensional movement through the soil matrix; & rapid downward movement through macropores-by-passing most of the soil matrix. These findings have major implications regarding the potential for contamination of groundwater by agrochemicals.

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GLEAMS AND THE VADOSE ZONE MODELING OF PESTICIDE TRANSPORT

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Interpretive Summary:
In recent years a number of numerical models have been proposed to evaluate the impact of agricultural chemicals on the environment. However, to have practical application, the model must have the ability to evaluate best management practices. One model that attempts to accomplish this goals is GLEAMS, groundwater loading effects of agricultural management systems. However, this model does not simulate chemical transport below the root zone and into underlying groundwater. As a consequence, a percolation route was developed and added to the GLEAMS model so that management systems and transport parameters could be evaluated in light of observed chemical concentrations in the groundwater. The proposed percolation route was discussed and simulations compared to actual field data for atrazine and carbofuran. Results indicate that in structured soils, chemical loading in groundwater is significantly underestimated. One possible explanation is that the enhanced chemical loading could be the result of preferential transport which GLEAMS does not attempt to address.

Technical Abstract:
A Vadose Zone Model (VZM) was developed to route the percolation component of GLEAMS from the root zone to the water table. Both horizontal and vertical movement of water and pesticides were considered in this modeling effort. Results indicate that insignificant amounts of pesticides reach the water table if a well structured profile was considered. It also indicates that the concept of perferential flow should be implemented into our prediction models for higher accuracy.

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TRANS OF POLLUTANTS IN VADOSE ZONE,ASAE

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THE ANALYSIS OF 4-NITROPHENOL IN FOG WATER

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Interpretive Summary:
Pesticides may volatilize after they have been applied to crops. Airborne pesticides may be trapped in rain or fog droplets and returned to earth. Not only pesticides, but also their breakdown products are transported in the atmosphere. We have detected some of the breakdown products of parathion in fog water. One of these, 4-nitrophenol, the subject of our research and we have developed a rapid analytical method for measuring trace quantities of 4-nitrophenol in collected fog water based on a procedure employing solid phase extraction.

Technical Abstract:
The atmosphere plays a key role in the transportation and deposition of pesticides. Fog droplets are responsible for the removal of amounts of pesticides from the atmosphere. Samples of fog water from California have been found to contain a number of pesticides including parathion. Transformation products of pesticides also occur. Among these, 4-nitrophenol and paraoxon probably arise by atmospheric oxidation of parathion. An analytical method, based on solid-phase extraction followed by gas chromatography, has been developed to measure concentrations of 4-nitrophenol at the parts per billion (ppb) level in fog water.

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ENZYMZTIC PRETREATMENT FOR EXTRACTION OF STARCH ENCAPSULATED PESTICIDES FROM SOILS

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Interpretive Summary:
Contamination of groundwater by agricultural chemicals is a problem receiving increasing attention. Much of the recent research has been directed at developing ways of modifying pesticide behavior in the soil. One modification that is currently being field tested in several states involves trapping the pesticide in a starch capsule. Evaluation of the effectiveness of starch encapsulation on behavior modification requires that methods are available to measure the amount of pesticide remaining in the soil. Existing methods are not adequate for recovering all pesticides remaining within the starch matrix, hence pesticide residue is underestimated. The present paper reports on a new method for releasing the pesticide from the starch capsule where it can subsequently be measured using standard recovery procedures. The new procedure involves treating the sample with an enzyme and heating the sample for one hour prior to extracting the pesticide from the soil. This new method adds approximately one hour to the recovery procedure and doubles the recovery of the pesticide from soil samples. This new method will be useful in studying pesticide behavior in field experiments when the pesticide has been applied in the starch encapsulated form.

Technical Abstract:
Recently a great deal of research attention has been directed towards modifying the behavior of agricultural pesticides suspected as nonpoint sources of groundwater contamination. One modification involves starch-encapsulation of pesticides which allows controlled release of the herbicide from a biodegradable matrix. Unfortunately, traditional analytical methods for recovering the parent compound trapped in the starch matrix are inadequate for chemicals with slow rates of release. Poor recovery prevents accurate mass balance assessment of these chemicals. An enzymatic (amylase) pretreatment was developed that allows quantitative recovery of the parent compound fro9m soil samples receiving the pesticide in the starch-encapsulated formulation. The inexpensive method adds approximately one hour to the extraction procedure and a two-fold increase in percentage recovery of starch encapsulated atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine). The enzyme pretreatment is not necessary for quantitative recover of pesticides that have rapid rates of release such as alachlor (2-chloro-2',6'-diethyl-N-methoxymethyl acetanilide). The method will be useful for studying how starch-encapsulation modifies pesticide behavior in the soil environment.

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WEED SCIENCE

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AQUEOUS OZONOLYSIS OF S-TRIAZINES. I. DESCRIPTION OF ATRAZINE DEGRADATION PATHWAY AND PRODUCT IDENTIFICATION

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Interpretive Summary:
Effective disposal of pesticide waste and equipment rinsate is desired to prevent contamination of groundwater and farm wells. A two stage process under investigation involves treatment of the waste with ozone followed by microbial degradation to give carbon dioxide, nitrogen, water and salts. Atrazine, one of the highest use herbicides, was found to be somewhat resistant to degradation relative to other pesticides. This study examined the overall mechanism by which ozone reacts with atrazine and the reaction products were isolated and characterized. Results demonstrated that the chlorine of atrazine was not removed and that the ring structure remained intact. This basic information is needed to further develop and optimize the waste disposal process.

Technical Abstract:
The aqueous ozonation of atrazine (2-chloro-4-ethylamino-6-isopropylamino-s-triazine) at pH 6 afforded four primary products: 6-amino-2-chloro-4-isopropylamino-s-triazine, 6-amino-2-chloro-4-ethylamino-s-triazine, 4-acetamido-2-chloro-6-ethylamino-s-triazine and 4-acetamido-2-chloro-6-isopropylamino-s-triazine. These compounds were subsequently degraded to 2-chloro-4,6-diacetamido-s-triazine, 4-acetamido-6-amino-2-chloro-s-triazine and 2-chloro-4,6-diamino-s-triazine. The amino alkyl groups are the first site of attack and are either removed or converted to the acetamide but not to the aldehyde. The s-triazine ring remains intact and the chlorine is not removed. Studies also demonstrated that the alkyl group is far more reactive than the amide moiety, which in turn is oxidized more rapidly than the amino group.

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